No. 609,943. Patented Aug. 30, 1898.

F. H. MERRILL.

DISPLACEMENT PUMP.

(Application filed Apr. 23, 1897.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.

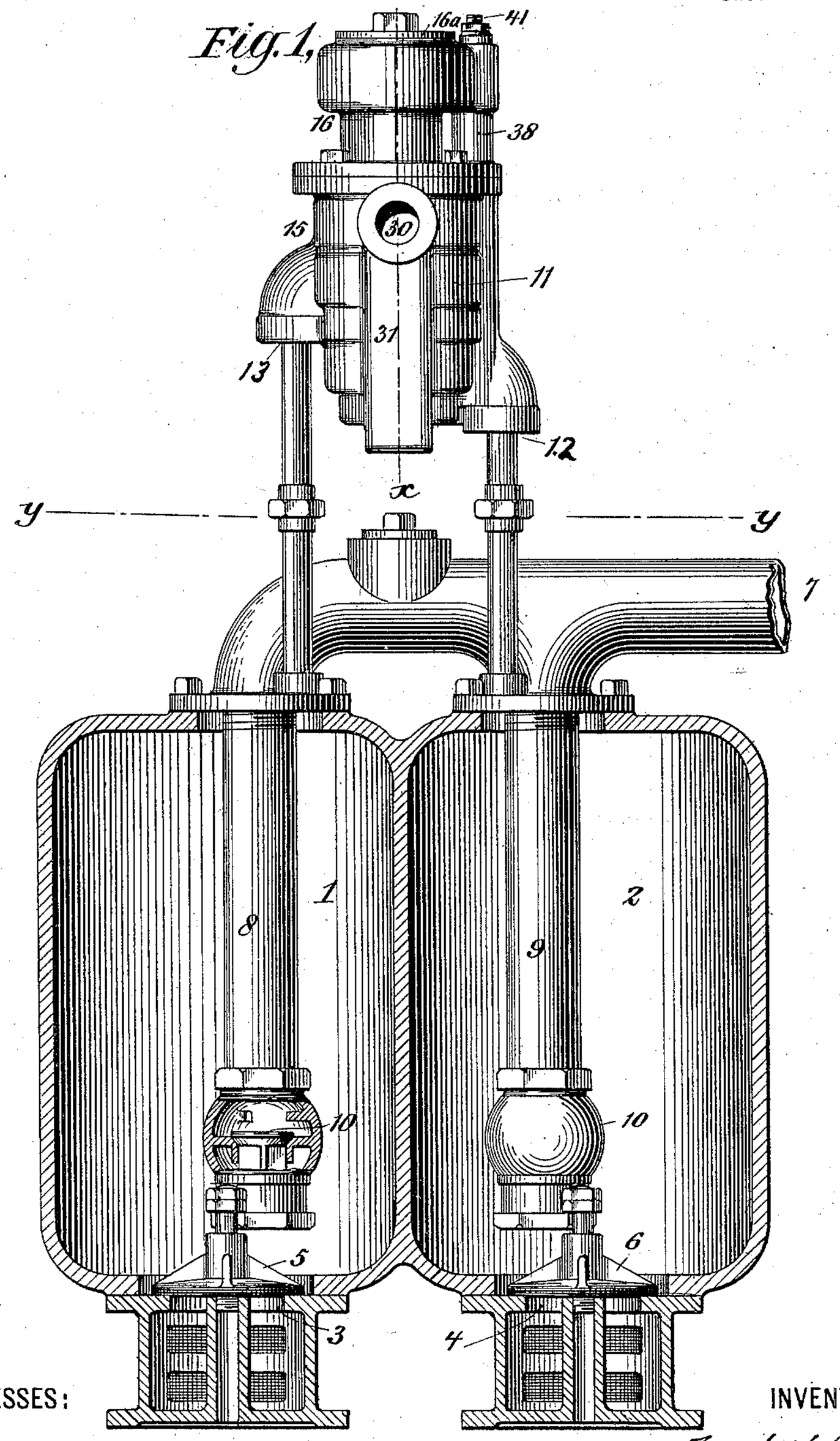

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Fig. 2.

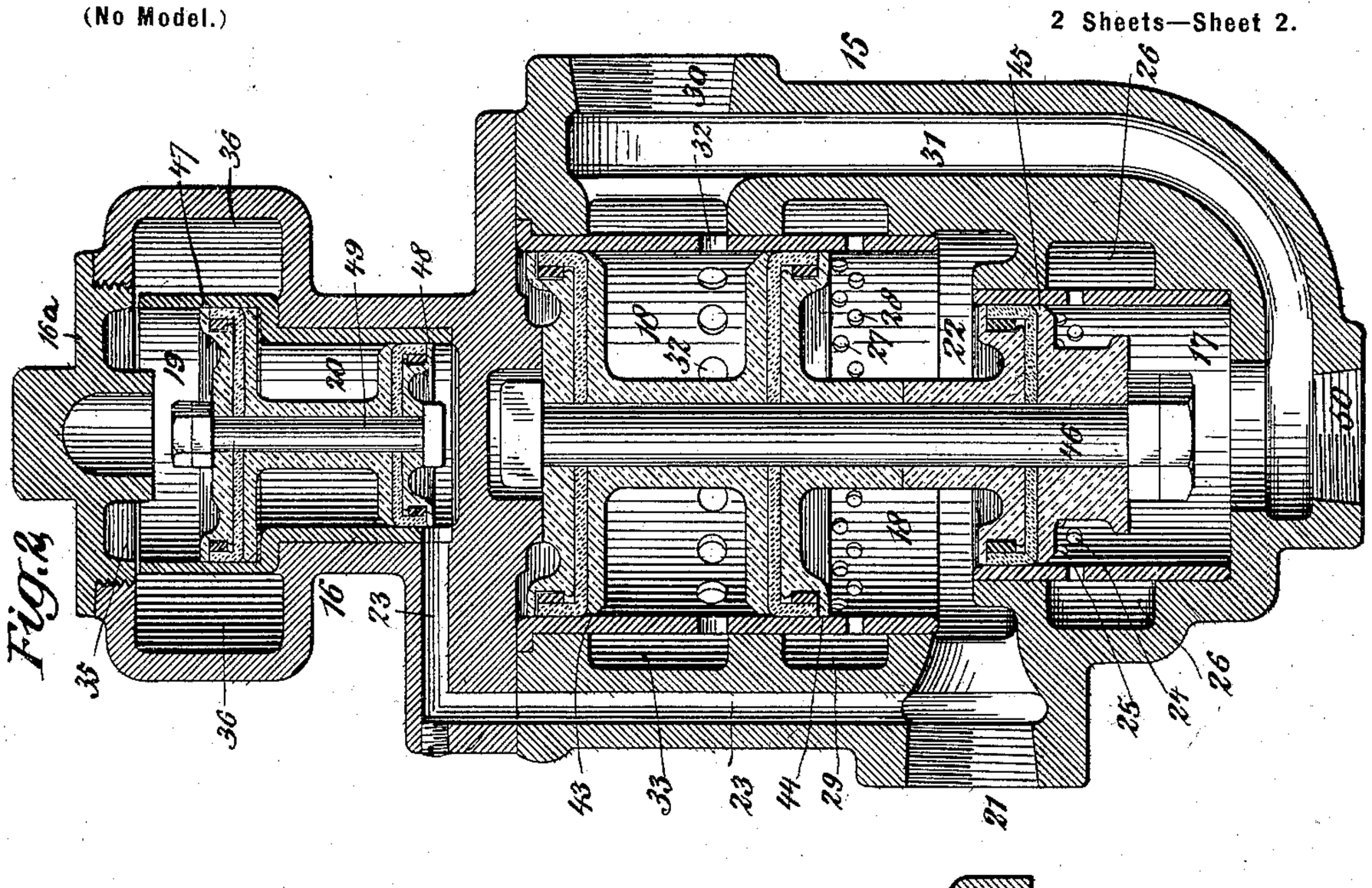
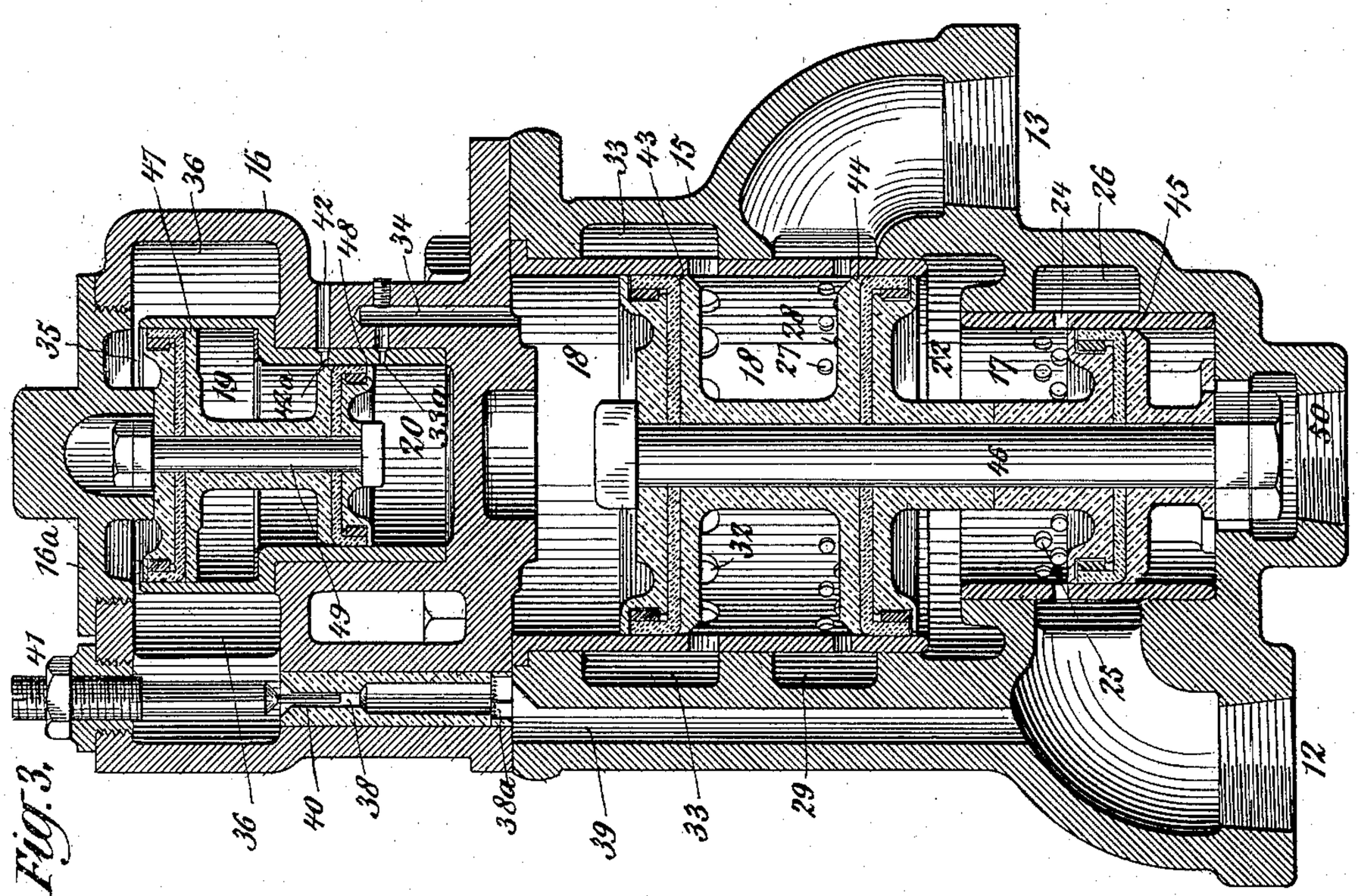


Fig. 3.



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DISPLACEMENT-PUMP.

SPECIFICATION forming part of Letters Patent No. 609,943, dated August 30, 1898.

Application filed April 23, 1897. Serial No. 633,488. (No model.)

To all whom it may concern:

Be it known that I, FRANK H. MERRILL, a citizen of the United States, and a resident of Plainfield, in the county of Union and State of New Jersey, have invented certain new and useful Improvements in Displacement-Pumps, of which the following is a specification.

The reciprocations of the main valve are pneumatically controlled independently of the liquid pumped. It is pneumatically shifted by alternating abruptly-applied pneumatic pressure and exhaust controlled by a pneumatically-operated supplemental valve, the motion of which is timed by a retarder.

In the accompanying drawings I have shown an apparatus of one form in which my invention may be embodied without intending thereby to limit myself to said form or to the arrangement, construction, or number of parts therein contained, excepting as the same are essential to the principle of my invention.

Figure 1 is a side view of the apparatus with the water-compartments in section. Fig. 2 is a vertical section of the air-valve mechanism on the plane *x*, Fig. 1. Fig. 3 is a vertical section of the same on a plane at right angles with the plane *x*.

y y represent the level of the water in which the water-compartments are submerged.

The water-compartments and their inlet and outlet passages are as follows:

1 and 2 are water-compartments, which are respectively provided with the bottom water-inlet openings 3 and 4, respectively closed by the lift-valves 5 and 6.

7 is the water-delivery pipe, which is provided with an intake located near the bottom of each water-compartment. The intake for compartment 1 is at the bottom of pipe 8 and the intake for compartment 2 is at the bottom of pipe 9. Lift-valve 10 controls the opening into pipe 8 and a similar lift-valve controls the opening into pipe 9.

The air-valve compartment 11 is connected on one side with the top of water-compartment 2 by pipe 12 and on the other side with the top of water-compartment 1 by pipe 13.

The shell of the air-valve compartment 11 may be constructed of two castings 15 and 16. (Shown in Figs. 2 and 3, in which the parts are represented to a scale.) The casting 15 contains the differential cylinders 17 and 18. The casting 16 contains the differential cylinders 19 and 20. The compressed air or gas supply opening 21 connects with the top of cylinder 17 and the bottom of cylinder 18 through the passage 22. It also connects with the bottom of cylinder 20 through the passage 23. The cylinder 17 connects with the pipe 12 through the double series of perforations 24 and 25 and the annular passage 26. The cylinder 18 connects with the pipe 13 through the double series of perforations 27 28 and the annular passage 29. The lower end of the cylinder 17 connects with the main exhaust-opening 30 through the passage 31. The cylinder 18 connects with the main exhaust-opening 30 through the series of perforations 32 and the annular passage 33. The cylinder 20 connects with the top of cylinder 18 through the passages 33ª and 34. The top of cylinder 19 is connected with the pipe 12 through the annular passages 35 36 and the passages 38 39. The passage 38 is throttled by the valve 40, which is carried and controlled by the set-screw 41.

42 is an exhaust-passage.

The valves and their relationship with the supply and exhaust ports are as follows: The valve-heads or plungers 43, 44, and 45 are bolted together by the bolt 46, making a differental valve consisting of the equal heads 43 and 44 and the smaller head 45. This differential valve is shown at the top of its stroke in Fig. 2 and at the bottom of its stroke in Fig. 3. The arrangement of the ports is such that at the top of the valve stroke the ports 24 25 are below the valve-head 45, the ports 27 28 are between the valve-heads 44 and 45, and the exhaust-ports 32 are between the valve-heads 43 and 44. When the valve is at the bottom of its stroke, the pressure-ports 24 25 are between the valve-heads 44 and 45, the pressure-ports 27 28 are between the valve-heads 43 and 44 and the exhaust-ports 32 are between the valve-heads 43 and 44. The valve-heads 47 and 48 are connected together by the bolt 49, so as to make a differential valve consisting of the larger head 47 and the smaller head 48.

The dimensions employed may be as follows: Diameter of valve-heads 43 and 44, four and one-fourth inches; diameter of

valve-head 45, three inches; diameter of valve-head 47, three inches; diameter of valve-head 48, two and one-eighth inches; diameter of passage 38, .125 of an inch; diameter of throttle-valve 40, .120 of an inch; length of stroke of differential valve 47 48, thirteen-sixteenths of an inch; length of stroke of differential valves 43 44 45, one and one-fourth inches. The ports 42ª and 33ª are each about three thirty-seconds of an inch in diameter. The differential cylinders 17, 18, 19, and 20 and the metallic portions of the valves and the walls of passage 38 and the throttle-valve 40 are made of non-corrosive metal. The outer casings 15 and 16 are of cast-iron. At 38ª the bottom of the passage 38 is covered by a wire screen of fine mesh to prevent any sediment from getting into the passage around the throttle-valve.

Operation when valves are positioned as shown in Fig. 3: Suppose compartment 2 to be full of water and compartment 1 to be empty and the valves to be in the position shown in Fig. 3. Compressed air entering at 21 passes through the passage 22 and the cylinder 17 and the ports 24 25 and the pipe 12 into compartment 2, whence it forces the water through the pipe 9 into the discharge-pipe 7. At the same time the head of water around the water-compartment raises valve 5, fills water-compartment 1, and drives the air out of water-compartment 1, through pipe 13, passage 29, ports 27 28, cylinder 18, ports 32 and passage 33, to the main exhaust 30. At the same time the pressure from 21 is communicated, through the passage 23, to the cylinder 20 on the under side of the valve-head 48, and thence, through the passages 33ª and 34, to the cylinder 18 above the valve-head 43. At the same time the compressed air entering at 21 passes through passages 39, 38, 36, and 35 into cylinder 19 above the valve-head 47. The passage 36 is enlarged sufficiently to form an air-chamber. The throttle-valve 40 delays the raising of the pressure in the chamber 36 by the entrance of compressed air to allow sufficient time for the water-compartment 2 to be emptied and the water-compartment 1 to be filled. The proper extent of this delay is secured by adjusting the set-screw 41, and thereby the extent to which the valve 40 projects into the passage 38. When the pressure above the valve-head 47 has increased to the necessary degree, the differential form of the valve will cause it to move downward, the air between the valve-heads escaping through the passage 42. The mouth of passage 33ª is located just below the piston-head 48 when at the top of its stroke, so that as soon as said piston-head commences to descend it traps the air contained within the cylinder 18 above the piston-head 43 and holds it entrapped until it has reached substantially the bottom of its stroke, when the mouth of passage 33ª is just above the top of cylinder-head 48, and the compressed air above the piston-head 43 in cylinder 18 is exhausted through passages 34 33ª, cylinder 20, and passage 42. As soon as this occurs the air-pressure between valve-heads 44 and 45, acting differentially upon them, will force the differential valve 43, 44, and 45 quickly to the top of its stroke, as shown in Fig. 2.

Operation when valves are positioned as shown in Fig. 2: Water-compartment 2 is now empty and water-compartment 1 is full. Compressed air entering at 21 proceeds through passage 22, cylinder 18, ports 27 28, passage 29, and pipe 13 into compartment 1, whence it forces the water, through pipe 8, into delivery-pipe 7. At the same time the head of water outside of compartment 2 raises valve 6 and fills compartment 2, forcing the air therefrom, through pipe 12, passage 26, ports 24 25, cylinder 17 and passage 31 to the main exhaust 30. At the same time the compressed air contained above the valve-head 47 and in the air-chamber 36 is gradually exhausted past the throttle-valve 40 and passages 38 and 39. This exhaust is delayed by the adjustment of the throttle-valve 40, so as to keep the pressure above the valve-head 47 long enough to permit compartment 2 to be filled; but when said pressure has been exhausted to the requisite degree the pressure supplied through passage 23 to cylinder 20 below valve-head 48 will force the differential valve 47 48 to the top of its stroke. The differential valve 43 44 45 will remain at the top of its stroke until the valve-head 48 has just at the top of its stroke passed the mouth of passage 33, whereupon the pressure in cylinder 20 will be communicated to cylinder 18 above the valve-head 43 through the passages 33ª and 34, so as to force the valve 43 44 45 to the bottom of its stroke. After this the operation first described will be repeated.

The structure described may be utilized as a single-acting pump by eliminating the operation of water-compartment 1 and plugging the ports 27 28, in which case the valve-heads 43 44 act substantially as a single head. The shell 16 forms a cover for the shell 15, by the removal of which cover the differential valve 43, 44, and 45 may be removed. The top of the shell 16 is closed by the head 16ª, upon the removal of which the differential valve 47 48 may be removed. An opening 50 may be plugged or utilized as the exhaust from the passage 31.

The function of the throttle-valve 40 is not essential to causing the automatic action of the valve 45 and supplemental valve 48. This would take place if the passage 39 were not throttled; but in that case the valve 45 would not pause between strokes and there would be no time for the displacement-compartment to fill with water. The function of the throttle-valve, therefore, is as a retarder, acting independently of the water pumped. It retards the movements of valve 48 throughout the stroke; but it only retards or delays the start of valve 45 on each stroke. When once

started on any stroke, valve 45 moves through its stroke with a quickness regulated by the size of the opening 33ª adequate for the proper operation of the pump without such shocks as would injure the valve. Viewing, therefore, the throttle-valve 40 as one form of retarder acting independently of the water pumped, I do not wish to be limited to the use of a throttle-valve as a retarder or to the compressed air as a retarding fluid, having already conceived other contrivances which would retard the valve 48, and thus indirectly retard the starts of valve 45 independently of the water pumped. I have shown the throttle-valve 40 acting upon the compressed air merely as the form of retarder that I prefer at the present time.

I claim—

1. In a displacement-pump, in combination, a displacement-compartment containing liquid ingress and egress openings, a main valve, a main-valve chamber, an exhaust therefrom, a supplemental valve, a supplemental-valve chamber, an exhaust therefrom, a main ingress compressed-gas passage leading to said main-valve chamber, a main egress compressed-gas passage leading from said main-valve chamber to said displacement-compartment, a branch compressed-gas passage leading through said supplemental-valve chamber and against a surface connected with said main valve and another branch compressed-gas passage leading against a surface connected with said supplemental valve, substantially as described, whereby said main valve is pneumatically actuated independently of the liquid pumped.

2. In a displacement-pump, in combination, a displacement-compartment containing liquid ingress and egress openings, a main valve, a main-valve chamber, an exhaust therefrom, a supplemental valve, a supplemental-valve chamber, an exhaust therefrom, a main ingress compressed-gas passage leading to said main-valve chamber, an exhaust therefrom, a main egress compressed-gas passage leading from said main-valve chamber to said displacement-compartment, a branch compressed-gas passage leading through said supplemental-valve chamber and against a surface connected with said main valve and another branch compressed-gas passage leading against a surface connected with said supplemental valve, substantially as described, whereby said main valve is pneumatically actuated independently of the liquid pumped; said supplemental valve being located outside the displacement-compartment.

3. In a displacement-pump, in combination, a displacement-compartment containing liquid ingress and egress openings, a main valve, a main-valve chamber, an exhaust therefrom, a supplemental valve, a supplemental-valve chamber, an exhaust therefrom, a main ingress compressed-gas passage leading to said main-valve chamber, a main egress compressed-gas passage leading from said main-valve chamber to said displacement-compartment, a branch compressed-gas passage leading through said supplemental-valve chamber and against a surface connected with said main valve and another branch compressed-gas passage leading against a surface connected with said supplemental valve, substantially as described, whereby said main valve is pneumatically actuated independently of the liquid pumped; said supplemental valve being located above the water-level.

4. In a displacement-pump, in combination, a duplex displacement-compartment each part of which contains liquid ingress and egress openings, a main valve, a main-valve chamber, an exhaust therefrom, a supplemental valve, a supplemental-valve chamber, an exhaust therefrom, a main ingress compressed-gas passage leading to said main-valve chamber, main egress compressed-gas passages leading from said main-valve chamber, respectively to the parts of said displacement-compartment, a branch compressed-gas passage leading through said supplemental-valve chamber and against a surface connected with said main valve, another branch compressed-gas passage leading against a surface connected with said supplemental-valve chamber, substantially as described, whereby said main valve is pneumatically actuated independently of the liquid pumped and controls the pressure in both parts of said duplex displacement-compartment.

5. In a displacement-pump, in combination, a displacement-compartment containing liquid ingress and egress openings, a main valve, a main-valve chamber, an exhaust therefrom, a supplemental valve, a supplemental-valve chamber, an exhaust therefrom, a main ingress compressed-gas passage leading to said main-valve chamber, a main egress compressed-gas passage leading from said main-valve chamber to said displacement-compartment, a branch compressed-gas passage leading through said supplemental-valve chamber and against a surface connected with said main valve and another branch compressed-gas passage leading against a surface connected with said supplemental valve, substantially as described, whereby said main valve is pneumatically actuated independently of the liquid pumped; said first-named branch passage branching from said main ingress-passage.

6. In a displacement-pump, in combination, a displacement-compartment containing liquid ingress and egress openings, a main valve, a main-valve chamber, an exhaust therefrom, a supplemental valve, a supplemental-valve chamber, a main ingress compressed-gas passage leading to said main-valve chamber, a main egress compressed-gas passage leading from said main-valve chamber to said displacement-compartment, a branch compressed-gas passage leading through said supplemental-valve chamber

and against a surface connected with said main valve and another branch compressed-gas passage leading against a surface connected with said supplemental valve, substantially as described, whereby said main valve is pneumatically actuated independently of the liquid pumped; said second-named branch passage branching from said main egress-passage.

7. In a displacement-pump, in combination, a displacement-compartment containing liquid ingress and egress openings, a main valve, a main-valve chamber, an exhaust therefrom, a supplemental valve, a supplemental-valve chamber, a main ingress compressed-gas passage leading to said main-valve chamber, a main egress compressed-gas passage leading from said main-valve chamber to said displacement-compartment, a branch compressed-gas passage leading through said supplemental-valve chamber and against a surface connected with said main valve and another branch compressed-gas passage leading against a surface connected with said supplemental valve, substantially as described, whereby said main valve is pneumatically actuated independently of the liquid pumped; said branch passages branching respectively from said main ingress and egress passages.

8. In a displacement-pump, in combination, a displacement-compartment containing liquid ingress and egress openings, a main valve, a main-valve chamber, an exhaust therefrom, a supplemental valve, a supplemental-valve chamber, an exhaust therefrom, a main ingress compressed-gas passage leading to said main-valve chamber, a main egress compressed-gas passage leading from said main-valve chamber to said displacement-compartment, a branch compressed-gas passage leading through said supplemental-valve chamber and against a surface connected with said main valve and another branch compressed-gas passage leading against a surface connected with said supplemental valve, substantially as described, whereby said main valve is pneumatically actuated independently of the liquid pumped; and a retarder whereby the movement of said supplemental valve is timed.

9. In a displacement-pump, in combination, a displacement-compartment containing liquid ingress and egress openings, a main valve, a main-valve chamber, an exhaust therefrom, a supplemental valve, a supplemental-valve chamber, an exhaust therefrom, a main ingress compressed-gas passage leading to said main-valve chamber, a main egress compressed-gas passage leading from said main-valve chamber to said displacement-compartment, a branch compressed-gas passage leading through said supplemental-valve chamber and against a surface connected with said main valve and another branch compressed-gas passage leading against a surface connected with said supplemental valve, substantially as described, whereby said main valve is pneumatically actuated independently of the liquid pumped; and a throttle whereby the duration of pressure against said surface connected with said supplemental valve is controlled.

10. In a displacement-pump, in combination, a displacement-compartment containing liquid ingress and egress openings, a main valve, a main-valve chamber, an exhaust therefrom, a supplemental valve, a supplemental-valve chamber, an exhaust therefrom, a main ingress compressed-gas passage leading to said main-valve chamber, a main egress compressed-gas passage leading from said main-valve chamber to said displacement-compartment, a branch compressed-gas passage leading through said supplemental-valve chamber and against a surface connected with said main valve and another branch compressed-gas passage leading against a surface connected with said supplemental valve, substantially as described, whereby said main valve is pneumatically actuated independently of the liquid pumped, and a throttle whereby both the pressure and exhaust against said surface connected with said supplemental valve are retarded.

11. In a displacement-pump, in combination, a displacement-compartment, a main valve regulating the pressure in the same, a passage whereby pressure is conducted against a surface connected with the main valve to move the same, a supplemental valve outside the displacement-compartment controlling the pressure in said passage, a passage independent of the displacement-compartment whereby the pressure and exhaust produced by the movements of the main valve are communicated with a surface connected with said supplemental valve and means whereby the movement of said supplemental valve is retarded, substantially as described, whereby the main valve independently of the liquid pumped controls itself by the aid of said retarded supplemental valve.

12. In a displacement-pump, in combination, a displacement-compartment containing liquid ingress and egress openings, a main piston-valve and a differential plunger for operating the same, cylinders therefor, a supplemental valve, a supplemental-valve chamber, a main compressed-gas passage leading through said main-valve cylinder, a branch compressed-gas passage leading through said supplemental-valve chamber against said plunger and means whereby said supplemental valve is controlled independently of the water pumped, substantially as described.

13. In a displacement-pump, in combination, a displacement-compartment containing liquid ingress and egress openings, a main piston-valve, and a differential plunger connected therewith, cylinders therefor, a supplemental piston-valve and a differential plunger connected therewith, cylinders therefor, a main compressed-gas passage leading

through said main valve-cylinder, a branch compressed-gas passage leading through said supplemental valve-cylinder against said first-named plunger and another branch compressed-gas passage leading against said second-named plunger, substantially as described.

14. In a displacement-pump, in combination, a displacement-compartment containing liquid ingress and egress openings, a main-valve chamber, an ingress pressure-passage to said main-valve chamber, an egress pressure-passage from said main-valve chamber, a pressure-controlling valve in said main-valve chamber, a branch passage whereby pressure for actuating said main valve is conducted from said ingress-passage against a surface connected with said main valve and mechanism independent of the displacement-compartment whereby said main-valve-actuating pressure is intermitted, said mechanism being mechanically disconnected from said surface, substantially as described.

15. In a displacement-pump, in combination, a displacement-compartment containing liquid ingress and egress openings, a compressed-gas-pressure-supply pipe leading thereto, a piston-valve controlling said pressure, a differential surface connected with said piston-valve, a differential cylinder containing said piston-valve and said differential surface, a passage whereby valve-actuating pressure is conducted independently of the displacement-compartment from said supply-pipe into said differential cylinder against said differential surface and mechanism outside of said displacement-compartment whereby said valve-actuating pressure against said differential surface is intermitted, substantially as described.

16. In a displacement-pump, in combination, a displacement-compartment, a main differential cylinder 17, 18, a valve therein containing the differential plungers 43 and 45, a supplemental differential cylinder 19, 20, a valve therein containing the differential plungers 47 and 48, a pressure-passage connected with the main cylinder between the plungers therein, an exhaust connected with the minor part of the main cylinder outside of the plunger contained therein, a port in said minor part of the main cylinder connected with said displacement-compartment, a port in the minor part of said supplemental cylinder, a passage connecting the same with the major part of said main cylinder outside of the plunger therein, a pressure-passage connected with the minor part of said supplemental cylinder outside of the plunger therein, an exhaust connected with said supplemental cylinder between the plungers therein, a passage connecting the major part of said supplemental cylinder outside the plunger therein with a passage to said displacement-compartment, substantially as described.

17. In a displacement-pump, in combination, a duplex displacement-compartment, a main differential cylinder 17, 18, a valve therein containing the plungers 43, 44 and the differential plunger 45, a supplemental differential cylinder 19, 20, a valve therein containing the differential plungers 47, 48, a pressure-passage connected with the main cylinder between the differential plungers 44, 45, an exhaust connected with the minor part of the main cylinder outside of the plunger therein, a port in said minor part of the main cylinder connected with part 1 of said displacement-compartment, an exhaust connected with the major part of the said main cylinder between the plungers 43 and 44, a port in said major part of the main cylinder coöperating with the plunger 44 and connecting with part 2 of said displacement-compartment, a port in the minor part of said supplemental cylinder, a passage connecting the same with the major part of said main cylinder outside of the plunger 43, a pressure-passage connected with the minor part of said supplemental cylinder outside of the plunger therein, an exhaust connected with said supplemental cylinder between the plungers therein, a passage connecting the major part of said supplemental cylinder outside the plunger therein with a passage to said displacement-compartment, substantially as described.

18. In combination, a differential cylinder 17, 18, a plunger in each part thereof, a connection between said plungers, a pressure-passage leading into the space between said plungers, an exhaust connected with the minor part of said cylinder outside of the plunger therein, a passage connected with the major part of said cylinder outside of the plunger therein, an auxiliary cylinder to which the last-named passage leads, a differential valve in said auxiliary cylinder, pressure and exhaust passages connected with said auxiliary cylinder and a throttle-valve in one of such pressure-passages whereby the transitions of pressure in said supplemental cylinder are timed, substantially as described.

19. In combination with a pressure-controlling valve and the ingress and egress passages thereof, the differential cylinder 47, 48, the differential plungers therein, pressure-passages connecting the major and minor parts of said cylinder respectively with said ingress and egress passages and a throttle-valve interposed in one of said pressure-passages whereby the speed of said plunger is regulated, substantially as described, independently of the body moved by the pressure controlled by said valve.

20. In combination, the alined plungers 43, 44, of substantial equal area and the differential plunger 45, the cylinder part 18, the cylinder part 17, the pressure-passage 21 entering between said cylinder parts, pressure-

ports in the minor cylinder part coöperating with plunger 45, pressure-ports in the major cylinder part coöperating with plunger 44, exhaust-ports between plungers 43 and 44 and exhaust-port outside of plunger 45, a passage connecting cylinder 18 outside the plunger 43 with the passage 21, a valve 48, a plunger 47 connected therewith and a passage leading from the ports 24 to said plunger, substantially as described.

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